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Development of a Cultural Heritage Digital Repository for the Ombilin Coal Mining Heritage of Sawahlunto

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ABSTRACT

Digital change and access to information in various ways allow memory institutions like libraries, archives, and museums (LAMs) to adopt modern cultural heritage management ideas and methodologies to be more efficient and effective. Ombilin Coal Mining Heritage of Sawahlunto (OCMHS) LAMs may develop a digital repository for cultural heritage and implement convergence. OCMHS had LAMs until UNESCO inscribed it as a World Heritage Site in July 2019. This research aims to develop a digital repository prototype based on free open-source software (FOSS). This study employs qualitative case studies. Study data was collected from observation, interviews, document analysis, and focus groups. The study findings demonstrate the development of a digital repository prototype named "Pusako Ombilin." However, significant development flaws remain. Optimizing LAMs' data integration, which is yet unconverted, is the next phase. Other than that, standardized guidebooks are needed. Based on the results, researchers propose that OCMHS develop "Pusako Ombilin" and create an easy-to-understand implementation guideline.

INTRODUCTION

The digital transformation of memory institutions provides new opportunities for cultural heritage preservation. It has also strengthened collaboration and convergence among libraries, archives, and museums (LAMs) at the Ombilin Coal Mining Heritage of Sawahlunto (OCMHS), located in Sawahlunto Municipality, West Sumatra Province, Indonesia. Since its designation as a UNESCO World Heritage Site in July 2019 (UNESCO, 2019), OCMHS has been recognized for its exceptional global significance. The site features an interconnected system of mines, mining towns, railways, and ports, all meticulously planned

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(see Figure 1). The Municipality of Sawahlunto prioritizes preserving, utilizing, and expanding cultural heritage, reinforcing its commitment to strengthening LAMs.

Figure 1: The Ombilin Coal Mining Heritage of Sawahlunto
Source: Government of West Sumatra and Ministry of Education and Culture of the Republic of Indonesia (2017 & 2018)

Currently, most LAMs at OCMHS provide conventional services such as collecting, preserving, and facilitating access to cultural heritage objects, conducting research, providing education, and engaging in community outreach. This illustrates a significant example of LAM convergence. At the same time, cultural heritage management in Indonesia is governed by several laws, including Law Number 11 of 2010 on Cultural Conservation, Law Number 43 of 2009 on Archives, Government Regulation Number 66 of 2015 on Museums, and Law Number 43 of 2007 on Libraries (West Sumatra Provincial Government and Ministry of Education and Culture of the Republic of Indonesia, 2017 & 2018).

This study develops a digital repository prototype based on free open-source software (FOSS) for implementation in the OCMHS LAM environment. LAMs at OCMHS play a crucial role in documenting, contextualizing, preserving, and indexing various aspects of cultural heritage as collective memory. To manage cultural heritage materials effectively, they must facilitate unrestricted information access across time and place. This aligns with the concept of LAM convergence via digital repositories. According to Botticelli et al. (2019), repositories are designed to store and manage data in its original format. These repositories are widely used for preserving durable information, including research data, scientific records, and digital assets related to cultural heritage. Several methods are used to construct digital repositories, including FOSS (Saroar et al., 2024). The adoption of FOSS in software development is widely practiced both domestically and internationally. Many organizations incorporate LAM convergence principles, leveraging FOSS as a foundational framework. However, adopting an information system requires continuous commitment and active engagement throughout its lifecycle. This study ensures uninterrupted system functionality. The SDLC model supports the sustainability of information systems, and its Waterfall Method was selected as the preferred approach for developing "Pusako Ombilin," aimed at managing cultural heritage resources efficiently (Pargaonkar, 2023).

LITERATURE REVIEW

Memory Institutions

Libraries, archives, and museums (LAMs) share administrative responsibilities and play a vital role in preserving cultural heritage and historical resources. These memory institutions function as knowledge hubs by organizing and managing information (Hendrawan & Shobaruddin, 2024). A key focus in LAM research is the convergence of information, emphasizing integrated metadata standards to enable seamless access. Beyond technological aspects, achieving efficient collaboration, knowledge exchange, and institutional motivation requires a fundamental shift in LAM administration (Katre, 2011). LAMs collect, preserve, interpret, and share tangible and intangible cultural heritage, including traditions, and historical, scientific, and social knowledge. Museums, archives, and libraries each fulfill distinct yet complementary roles. Their core functions include resource acquisition, conservation, research, exhibitions, education, accessibility, community engagement, and policy advocacy (Hendrawan et al., 2024).

Convergence

Convergence in information refers to the increasing interdependence of organizations, making them unable to operate in isolation (Warren & Matthews, 2019). Within LAMs, convergence can reduce costs, enhance collections, introduce new services, and attract more users (Marty, 2014; Constantine et al., 2018). Institutions engaging in convergence must strategically select collections for digitization to create inclusive environments. LAMs facilitate access to diverse knowledge and creative experiences that transcend geographical, temporal, and linguistic barriers. Byrne (2015) describes LAMs as repositories of public knowledge, while Robinson (2019) highlights convergence as a process that strengthens interdependencies among institutions. The integration of information and communication technology (ICT) has transformed how information is collected, stored, and retrieved. Since the 1990s, digitization has drawn attention from scientific and policy communities, accelerating LAM convergence (Given & McTavish, 2010; Vårheim et al., 2019). Research shows that user engagement with digital libraries, archives, and museums fosters knowledge creation and supports convergence initiatives. Rayward (1998) identified digitization as a driving force behind LAM convergence, a trend now widely adopted as a cultural strategy in many industrialized nations (Inkeles, 2019).

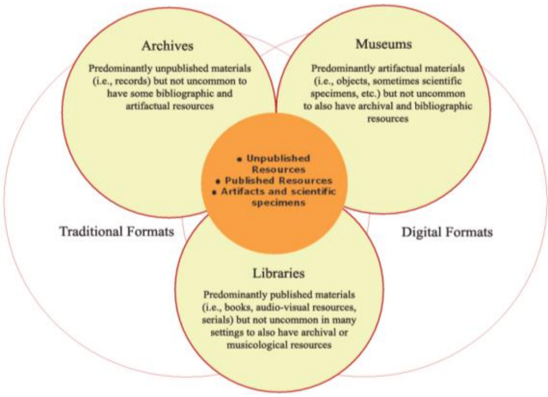

Figure 2: Library, Archive, Museum Convergence Visualization
Source: Timms (2007)

Digitization has significantly impacted LAMs by enhancing access to digital resources (Rasmussen, 2019). Expanding digital accessibility ensures that users can efficiently retrieve information worldwide. Convergence is essential for improving access, streamlining knowledge acquisition, and preserving cultural collections systematically over time (Stauffer, 2021).

Digital Repository

The widespread availability of information across industries highlights the impact of digital transformation, enabling the effective use of information communication technology (ICT). ICT supports various aspects of life, including generating, organizing, storing, transmitting, and distributing information

(Pearlson, 2024). Advances in ICT have driven the creation of digital information, allowing seamless integration of data and knowledge, thus improving access to and management of cultural heritage information. Higgins (2013) and Bastian (2017) emphasized that memory institutions, such as libraries, archives, and museums (LAMs), have been significantly influenced by ICT advancements. These improvements have enhanced the retrieval and accessibility of cultural heritage information (Ruthven & Chowdhury, 2015).

LAMs are recognized as information and knowledge hubs that efficiently manage cultural assets while ensuring accessibility. Many individuals use LAMs for research, education, skill development, and recreation. As key institutions for preserving cultural heritage, LAMs must adopt innovative techniques for managing and presenting cultural heritage materials to meet user needs while enhancing engagement. To manage large volumes of information and address challenges in storing, organizing, and sharing data, information professionals employ various technologies. Digital repositories, often developed internally to meet specific needs, play a crucial role in digitization efforts. These repositories store diverse data types and rely on metadata for organization. Their primary function is to facilitate data storage and retrieval (Gaona-García et al., 2017; Martins et al., 2023). Table 1 provides an overview of different digital repository systems. These systems are essential for identifying, categorizing, managing, and preserving cultural heritage materials, as well as fostering collective memory and cultural identity.

Table 1: Types of Heritage Information Systems

Numb.	Types	Pro's	Con's
1	Physical (document and photographic inventories and catalogs)	+ Simple to set up + Low cost	- Typically, linear or hard to cross-index - Hard to search or query - Physical storage requirements can become a challenge
2	Localized electronic databases	+ Highly customizable + Relatively easy to get started with + Simplifies indexing	- Interaction with other inventories is difficult - Non-standard, specialized query tools hard for novice users - Adding and managing data can be complex
3	Geographic Information Systems (GIS)	+ Strong data management potential + Highly customizable	- Requires considerable input of mapping info. - Steep learning curve. - Can be costly
4	3D Earth Viewers (online GIS with spatial imagery)	+ Combines advantages of GIS with an intuitive and easy-to-understand 'real' background	- Not as useful for non-spatial data - Nothing more than a nice visual interface (i.e. little data management and requires other tools to extend)
5	Hybrid, shared, 'Web 2.0' systems with relational data structures, XML, and other standards	+ Highly customizable, adaptable, and shared	- Emerging technology

Source: Santana-Quintero et al. (2004)

While digital repositories offer search and browsing features, they lack the advanced data analysis capabilities of information systems. However, they are ideal for long-term storage and shared access among multiple users (Hendrawan et al., 2024). To maximize their benefits, LAMs require essential components such as software, hardware, human resources, policies, and users.

Free Open-Source Software

The digital repository at OCMHS is designed using freely licensed open-source software governed by the GNU public license. This software can be accessed, modified, and shared without restrictions. According to Lochhaas and Moore (2010), free open-source software (FOSS) allows users to view its source code, understand its structure, modify it, and develop new iterations for commercial or functional improvements. FOSS provides users the flexibility to examine, customize, and enhance software performance (August et al., 2021).

System Development Life Cycle

The development of the digital repository for LAMs at OCMHS follows the System Development Life Cycle (SDLC) using the Waterfall model, a structured and sequential approach. This model progresses through communication, planning, modeling, construction, and deployment (see Figure 3). The phases are as follows: 1) Communication involves project initiation and requirements gathering. This phase ensures clear communication with users to define goals, analyze issues, and identify necessary features before development begins; 2) Planning, focuses on estimating resources, scheduling tasks, and tracking progress. This phase includes risk assessment, work scheduling, and process monitoring; 3) Modeling, encompasses analysis and design of system architecture, including data structures, software components, interface layouts, and programming algorithms to provide a clear framework for development; 4) Construction, involves coding and testing. The system is translated into machine-readable code, followed by testing to ensure functionality and reliability; 5) Deployment covers software delivery, user support, and feedback collection. The software is implemented as agreed with users, followed by ongoing maintenance and further improvements based on user input.

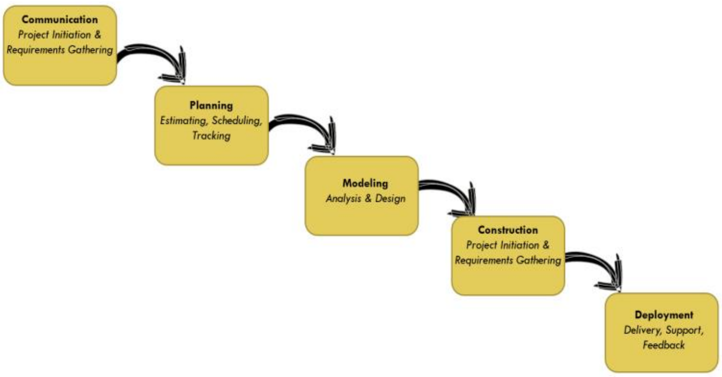

Figure 3: Waterfall Model Development.
Source: Roger and Bruce (2015)

In this study, the researcher used CollectiveAccess (CA), a system designed to create digital repositories based on FOSS, specifically for managing cultural heritage information resources in LAMs at OCMHS. CA provides a structured approach to managing, describing, and discovering digital and physical collections within LAMs. It efficiently handles large-scale information resources and supports multiple metadata standards and media formats. CA consists of two main components: Providence and Pawtucket. Providence serves as the "back-end" for information resource description, enabling users to input metadata for various objects. CA allows flexible customization of metadata formats, ensuring compatibility with diverse information resources. It supports multiple metadata standards, including Dublin Core, PBCore, VRA Core, DarwinCore, CDWA Lite, and MARC21. Pawtucket functions as the "front-end," providing users with access to metadata stored in Providence. The default Pawtucket interface includes elements such as home, about, explore, advanced search, and gallery. Additional plugins can enhance its functionality.

Like other digital repository software, CA allows users to extend its capabilities. CA includes integrated functionalities in two key areas:

a) Data modeling: Supports multiple metadata standards for LAMs, including Dublin Core, VRA Core, DACS, and ISAD (G); Metadata configurations can be customized using XML profiles and front-end pages; Integrated information services such as the Union List of Artist Names (ULAN) Catalogue and Library of Congress Subject Headings (LCSH); Advanced search capabilities and item organization by location; and Comprehensive documentation and free online community support.

b) Media processing: Supports various media formats, including videos, images, audio, PDFs, and 3D files; Enables data migration and format conversion on a predefined timeline; Annotation features for documents, images, audio, and video files; HTML5 pan and zoom functionality for high-resolution image viewing; and LibreOffice-generated previews for Microsoft file formats.

These capabilities emphasize the need for ongoing development and integration to ensure the repository meets user needs and fosters collaboration among LAMs. This research contributes to the broader discourse on digital transformation in cultural heritage management by advocating innovative methods to enhance accessibility and preservation. CA provides a flexible, user-friendly system tailored to the complex requirements of LAMs, benefiting both information professionals and end-users.

METHODOLOGY

Design

This study employs a qualitative case study approach. Explanatory research examines partial relationships between variables (Marshall & Rossman, 2014). The qualitative method follows an inductive approach, where meaning and understanding emerge from field data (Gorman & Clayton, 2005). This research focuses on a case study within the OCMHS. This method was chosen for its ability to explore the challenges and opportunities of implementing a digital repository in a heritage site. A qualitative case study provides flexibility in capturing insights from multiple stakeholders, including librarians, archivists, and museum curators, while addressing the complexities of technological adaptation within the OCMHS environment. The approach facilitates a comprehensive understanding of the institutional, technological, and social dynamics influencing the sustainability of digital heritage initiatives. This approach facilitates a comprehensive understanding of the institutional, technological, and social dynamics influencing digital heritage sustainability.

DATA COLLECTION

Data collection took place from April to July 2024 using observation, interviews, document analysis, and focus groups. The study follows the SDLC Waterfall model for software, hardware, and system design. Table 2 outlines the research focus.

Table 2: Details of Research Focus

Numb.	Research Focus	Description
1	Hardware	Client Server Supporting equipment
2	Software	Programming Language Database Structure Operating System Web Server Requirements

3	SDLC	Communication Planning Design Construction or code test Deployment or test

FINDINGS OF THE STUDY

CollectiveAccess (CA) is a free and open-source software (FOSS) that facilitates the convergence of libraries, archives, and museums (LAMs). Governed by the General Public License (GPL), CA allows users to access, modify, and distribute its source code, provided the attribution notice remains intact. Based on focus group discussions and the cultural significance of OCMHS, the digital heritage repository has been named "Pusako Ombilin." This repository was developed by adapting and enhancing CA. The primary objective of "Pusako Ombilin" is to document and preserve the collective memories, vision, and historical background of OCMHS.

Additionally, this system aims to empower stakeholders to shape OCMHS's future by ensuring high performance, adapting to technological advancements, and fostering an innovative organizational culture. The Sawahlunto Municipality and the Government of Indonesia have demonstrated strong commitment by allocating substantial funding and establishing a dedicated management agency to oversee OCMHS operations. The need for a digital cultural heritage repository is driven by the goal of enhancing user accessibility to cultural heritage information. The following section presents the study findings on the development of "Pusako Ombilin."

Hardware Support

Hardware plays a crucial role in sustaining "Pusako Ombilin." The prototype has received positive feedback from various user groups due to its interoperability. Below is an overview of hardware requirements:

1. Server Computers: Digital repositories require reliable server infrastructure. "Pusako Ombilin" is hosted on a dedicated virtual machine configured for optimal performance. The server is physically housed at the OCMHS ICT Unit, ensuring stability and security. The Director of the OCMHS Public Library and Archives stated:
   "The implementation of digital cultural heritage repositories, particularly at world heritage sites like OCMHS, will be supported by all stakeholders, including our leadership. We will provide the required server specifications to ensure seamless operation." (Interview conducted on May 10, 2024)

2. Client Computers: These computers allow users to access and manage repository content. The OCMHS museum currently operates two computers and plans to acquire more to support visitor access. The Museum Director commented:
   "Our museum has two computers capable of handling this application. We plan to add more to support digital access for visitors." (Interview conducted on May 12, 2024)

3. Supporting Equipment: Additional ICT peripherals, such as scanners, cameras, printers, and barcodes, support repository management. Respondents highlighted the need for improved infrastructure:
   a) Archivist: *"We require advanced scanning machines, as our current equipment is insufficient."* (Interview conducted on May 22, 2024.)
   b) Librarian: *"Additional media transfer tools, including digital cameras, are necessary." (Interview conducted on May 22, 2024)*

c) Curator: *“The museum still needs to standardize media transfer infrastructure.” (Interview conducted on May 21, 2024)*

Software Requirements

Software is essential for optimizing repository operations. It facilitates interaction between users and hardware components. Key software elements include:

1. Operating System: The "Pusako Ombilin" server runs on Linux, chosen for its scalability and security. The OCMHS software engineer remarked:
   “Linux is the best option for server operations due to its stability and compatibility.” (Interview conducted on May 21, 2024)

2. Database Management: "Pusako Ombilin" uses MySQL, an open-source database system known for efficiency and integration. The software developer stated:
   “MySQL allows seamless data management and integration with multiple programming languages.” (Interview conducted on May 23, 2024)

3. Programming Language: The repository is developed using PHP, HTML, CSS, JavaScript, TypeScript, and XML. This selection enhances flexibility and future scalability. The software developer noted:
   “PHP ensures easy maintenance and is supported by extensive documentation and online communities.” (Interview conducted on May 24, 2024)

4. Web Server: "Pusako Ombilin" operates using the Apache Web Server, chosen for its stability in hosting web applications. The software engineer added:
   “Apache provides robust support for web-based repository applications.” (Interview conducted on May 24, 2024)

These findings underscore the importance of integrating reliable hardware and software components to ensure the repository’s functionality and sustainability. Future enhancements should focus on improving infrastructure, expanding stakeholder engagement, and refining digital access strategies. When designing and building a system, following a structured process is essential. In a dynamic organization, system design provides a clear framework for implementing key components. The primary goal is to transition from traditional methods to modern, computerized processes, enabling efficient data management and high-quality information production. LAMs OCMHS conducted system design activities using "Pusako Ombilin," developed with CA software, following the SDLC Waterfall approach. The following sections detail the key phases of SDLC in the design process.

1. Communication: Before initiating technical tasks, effective communication and collaboration with stakeholders are essential. According to Alzayed and Khalfan (2022), stakeholders include individuals or groups invested in a project's success. The objective is to gather requirements and define system functionalities (Karita et al., 2021). Communication is crucial for aligning expectations and ensuring clarity. The researcher at OCMHS, responsible for the information system center and ICT infrastructure, collaborates with software engineers to develop “Pusako Ombilin.” This phase also involves identifying system requirements through discussions with museum curators, archivists, librarians, and memory institution directors at OCMHS, as summarized in Table 3.

Table 3: Issue Details Obtained During the Communication Phase

OCMHS Public Library and Archives	OCMHS Museum	Needs
Convergence Factor	An application should be developed for the OCMHS museum.	The OCMHS museum does not have a digital asset storage application.
Integration of the OCMHS Public Library and Archives collections	An OCMHS archival system is required to preserve the archives or historical records and serve as a memory institution.	Metadata modification based on the collections in the OCMHS LAMs.
		OCMHS LAMs users and stakeholders need a collection donation or contribution form.

2. Planning: A structured plan simplifies complex projects. The planning phase establishes a roadmap outlining software engineering tasks, potential risks, resource needs, deliverables, and timelines (Roger & Bruce, 2015). According to Hossain (2023), this phase includes scheduling technical activities, assessing risks, defining deliverables, and monitoring progress. OCMHS employs a planning workflow starting with a flow diagram to define new features, such as metadata schemas, ensuring they align with project goals. A key component in planning is metadata schema selection, which facilitates resource identification and retrieval. Available schema options for “Pusako Ombilin” include Dublin Core, DACS, MARC21, and CDWA, as shown in Table 4.

Table 4: Metadata Standard

Archives	Museum	Library	Donation/Contribution
DACS	CDWA	MARC21	Dublin Core

3. Modeling: Modeling is essential across various fields, from architecture to software development. It provides a structured representation of the system, illustrating its components and their integration (Bajaj et al., 2021). Initial sketches evolve into detailed designs to refine solutions. According to Akdur et al. (2018), software engineers use models to better understand system requirements and develop an effective design. In this phase, the system's architecture, data structures, software components, interface layouts, and algorithms take shape. Figure 4 presents the sitemap of the CA software, where the login or backend page is in the top left corner, enclosed by a blue frame. After authentication, users access the administrator dashboard (grey frame). The main page (red frame) provides navigation options, allowing users to manage items and collections. This structured approach ensures a well-organized system design, facilitating a seamless transition from traditional to digital cultural heritage management.

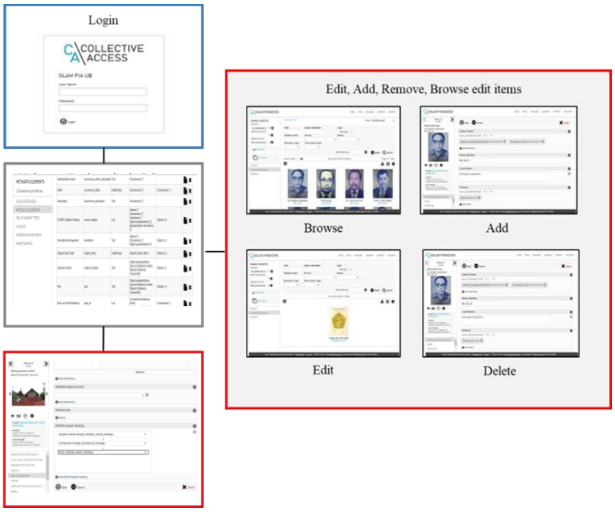

Figure 4: CollectiveAccess Sitemap

Figure 5 illustrates the design structure of the front-end and backend components. The front-end serves as the visual interface for users interacting with the website or application. It is implemented using the Bootstrap framework, an open-source CSS framework designed for front-end web development. Bootstrap includes pre-designed components and layouts built with HTML, CSS, and JavaScript. The backend of "Pusako Ombilin" is developed using PHP and MySQL and runs on the Apache web server.

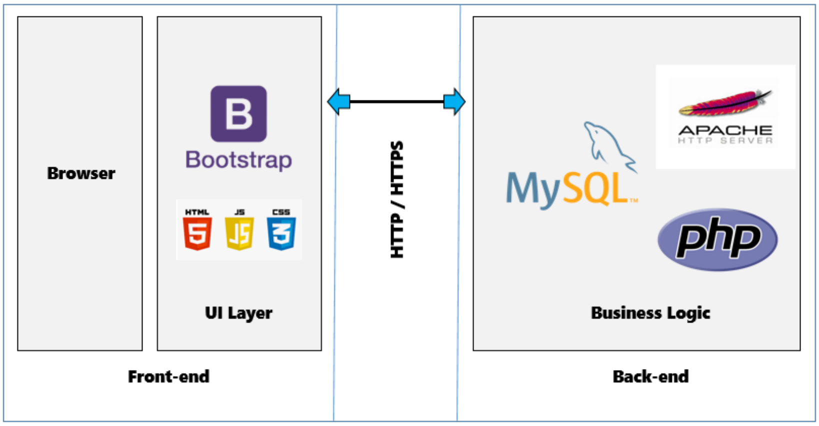

Figure 5: Design Structure View for CollectiveAccess Administrator Page

4. Construction: Once the design is finalized, implementation begins. According to Jakimoski et al. (2022), this phase involves coding, either manually or through automation, followed by testing to identify and fix errors. At this stage, the focus is on integrating interface elements and system functionalities for end-users. Figure 6 illustrates the transition from the default front-end display of "Pusako Ombilin" (red frame) to a customized version (blue frame), reflecting modifications based on prior design and modeling stages.

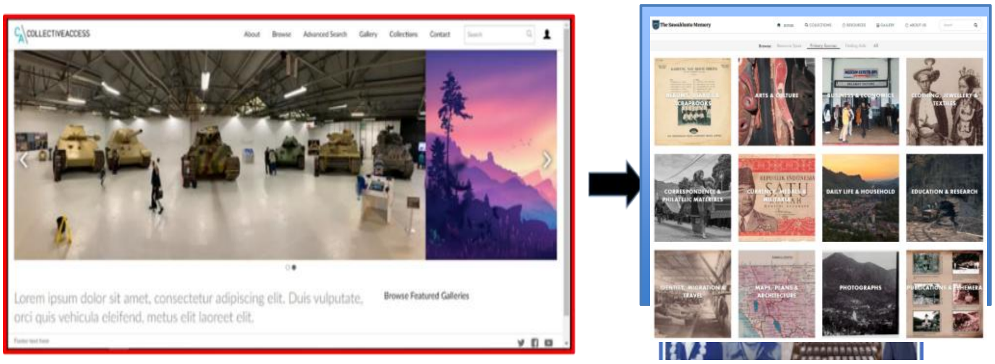

Figure 6: Custom Display on Collective Access Frontend to “Pusako Ombilin”

The next step involves defining the metadata schema, as shown in Figure 7 of the "Pusako Ombilin" document. Metadata categorizes and differentiates between archives, museums, libraries, and benefactors. It plays a crucial role in organizing and describing objects, with entries generated manually or automatically. In "Pusako Ombilin," metadata is customized to meet specific user needs.

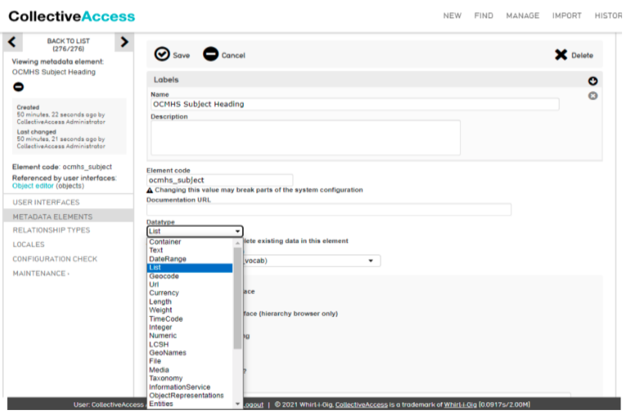

Figure 7: Custom Frontend View from CollectiveAccess to “Pusako Ombilin”

5. Deployment: The software is delivered to the client as either a fully developed product or an early version requiring further refinement. Clients then evaluate the system and provide feedback as part of the assessment process (Remencius, 2016). The final stage of system design involves prototype testing to ensure functionality. "Pusako Ombilin" was tested by software developers, librarians, archivists, and museum curators at OCMHS. In collaboration with the OCMHS software engineer, focus group discussions further refined the prototype. Observations indicate that the "Pusako Ombilin" testing phase produced positive results. The system effectively serves as a digital repository for photos, videos, and other archival materials, preserving collective memory across collections, including archives, libraries, and museums. Another key feature is the OCMHS history gallery, which presents the site's history in a visually engaging format. Additionally, a donor/contributor form allows stakeholders to contribute books, artifacts, and documents to the repository.

The implementation of "Pusako Ombilin" demonstrates the potential of digital repositories in managing cultural heritage information at OCMHS. The system is now operational, with contributions from curators, archivists, librarians, software engineers, and memory institution directors. Future enhancements should focus on usability improvements and the development of a user-friendly manual. This study highlights the importance of continuous development and integration to ensure "Pusako Ombilin" meets evolving user needs while fostering collaboration among LAMs.

Expanded Discussion on Practical Challenges and Scalability of "Pusako Ombilin"

The implementation of "Pusako Ombilin" faces several challenges, particularly in technological infrastructure, funding, institutional coordination, and user engagement. A key technical issue is integrating diverse cultural heritage data from LAMs at OCMHS. Many collections remain in physical format, requiring extensive digitization that aligns with metadata standards such as Dublin Core and CDWA (Santana-Quintero et al., 2004). Maintaining a digital repository based on FOSS like CA also requires continuous updates and expert oversight. However, Sawahlunto lacks IT professionals with FOSS expertise, posing sustainability risks (Lochhaas & Moore, 2010). Additionally, "Pusako Ombilin" currently relies on local servers with bandwidth and storage limitations, restricting scalability (Martins et al., 2023).

Institutional and organizational barriers further complicate implementation. Successful deployment depends on multi-stakeholder engagement, requiring collaboration between local government, heritage managers, librarians, archivists, and museum curators. However, differing institutional priorities and bureaucratic hurdles make coordination difficult (Marty, 2014). User engagement is another challenge, as digital literacy levels vary among LAM professionals and the public in Sawahlunto. Training and capacity-building programs are necessary to promote effective use of the repository (Hendrawan & Shobaruddin, 2024). Scalability is a crucial concern. Expanding "Pusako Ombilin" beyond OCMHS requires a roadmap for integration with Indonesia's broader digital heritage initiatives and other UNESCO World Heritage Sites such as Borobudur and Prambanan. Future upgrades should explore cloud-based deployment and mobile-friendly interfaces to improve accessibility for national and international researchers (Gaona-García et al., 2017). Additionally, sustainable funding models, including public-private partnerships, UNESCO grants, or crowdfunding, should be pursued to ensure long-term viability (Byrne, 2015).

Additional Empirical Validation and Comparative Analysis

To strengthen "Pusako Ombilin," comparisons with global digital repositories provide valuable insights. Europeana, the Digital Public Library of America (DPLA), and Trove in Australia serve as benchmarks. Europeana operates as a metadata aggregator for European cultural institutions (Rasmussen, 2019), whereas "Pusako Ombilin" follows a decentralized model using CollectiveAccess. DPLA facilitates cross-institutional collaboration through decentralized data storage and aggregation (Robinson, 2019), an approach that "Pusako Ombilin" could adopt. Trove, managed by the National Library of Australia (Warren & Matthews, 2019), this emphasizes user-driven contributions, offering a model for increasing participatory engagement in "Pusako Ombilin could adopt."

For empirical validation, future research should incorporate qualitative and quantitative assessments. User experience (UX) surveys among museum visitors, archivists, and researchers can measure satisfaction, accessibility, and usability (Miles et al., 2014). Additionally, system performance should be tested based on benchmarks such as page load speed, search accuracy, and data retrieval efficiency across different devices (Jakimoski et al., 2022). Expanding stakeholder interviews with archivists, museum curators, and software engineers will further refine usability features (Marshall & Rossman, 2014).

Broader Implications for LAMs Beyond Sawahlunto

The development of "Pusako Ombilin" has broader implications for LAM convergence beyond OCMHS. First, it provides a scalable framework for developing digital repositories at other UNESCO

World Heritage Sites in Indonesia, including Borobudur Temple Compounds, Prambanan Temple Compounds, and Tana Toraja, which currently lack a unified digital repository model (Higgins, 2013). Second, "Pusako Ombilin" highlights the importance of LAM collaboration in digital preservation. Its integration model can be applied to national networks of LAMs, improving data exchange and reducing institutional silos (Stauffer, 2021). Third, the policy and governance recommendations from this project could encourage the Ministry of Education and Culture of Indonesia to formalize a national digital heritage repository strategy and introduce legal frameworks to ensure sustained funding for LAM digital preservation (Katre, 2011). By addressing these challenges, incorporating empirical validation, and defining broader implications, "Pusako Ombilin" serves as a pioneering model for digital cultural heritage preservation in Indonesia. Future efforts should focus on pilot testing, establishing strategic LAM partnerships, and securing sustainable funding to ensure long-term success.

LIMITATIONS AND RECOMMENDATIONS

This study found several limitations that need to be overcome to be successful. The challenge of developing the “Pusako Ombilin” prototype is a major obstacle, this makes it impossible to combine data from LAMs at OCMHS without a variety of digital resources that are already available and ready to be transferred effectively. The absence of a manual means that installation and use of digital repositories will be hampered. Then a lack of funding support and technological expertise can limit repository maintenance and improvement. User engagement with digital repositories can be low due to a lack of knowledge and understanding of their function. These differences can significantly decrease repository utilization, thereby compromising the goal of increasing the availability of cultural heritage resources. There are also several recommendations put forward to overcome these various limitations, namely that data integration must be prioritized to include all related LAMs data into "Pusako Ombilin." Stakeholders need a simple implementation guide to utilize "Pusako Ombilin" properly. Information professionals in OCMHS LAMs need more training and capacity building to engage with digital repositories. A continuous evaluation and feedback mechanism will also help the repository in adapting to user demands by identifying areas for improvement. To become a useful instrument for cultural heritage management, digital repositories must overcome these obstacles and implement the strategies they offer.

In the future, a similar study could be conducted incorporating the most effective methods for managing digital repositories in the OCMHS, which may provide significant insights. This research aims to find effective tactics and frameworks that can be adapted to the specific context of OCMHS, with a particular focus on user engagement and resource optimization. Additionally, it is crucial to carry out research that evaluates the feasibility of the repository. This involves examining financing options, cooperation opportunities, and tactics for involving the community. These endeavors are essential to guarantee the repository's long-term viability and ability to accommodate evolving user requirements and technology progress.

CONCLUSION

This study underscores the importance of a structured approach in designing and developing a digital repository for libraries, archives, and museums (LAMs), also known as memory institutions. The "Pusako Ombilin" system, built using the free open-source software (FOSS) CollectiveAccess (CA), follows the sequential development process of the systems development life cycle (SDLC) waterfall model. This process includes communication, deployment, and transitioning from traditional to digital methods, enabling efficient data processing. The "Pusako Ombilin" system demonstrates the effective application of free open-source software in managing cultural heritage data. It highlights the necessity of methodical design procedures to create functional, user-friendly information systems. This research contributes to the broader discourse on digital transformation in cultural heritage management, particularly for LAMs at world heritage sites. It advocates for innovative approaches to improve accessibility and ensure the long-term preservation of cultural heritage.

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